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Kojima et al.

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(54) **IMAGE FORMING APPARATUS INCLUDING FIRST AND SECOND BIAS VOLTAGE SUPPLY DEVICES**

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May 24, 2013 (JP) 2013-110185

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G03G 21/00 (2006.01)

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CPC ***G03G 21/0035*** (2013.01); ***G03G 21/0023*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/0035; G03G 21/0023
USPC 399/353, 354
See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus includes a first image forming device, a plurality of second image forming devices, a first bias voltage supply device, and a second bias voltage supply device. The first image forming device and the second image forming device form a toner image. The first bias voltage supply device applies a bias voltage to a first component of the first image forming device. The second bias voltage supply device applies a bias voltage to a second component of each of the plurality of second image forming devices.

19 Claims, 11 Drawing Sheets

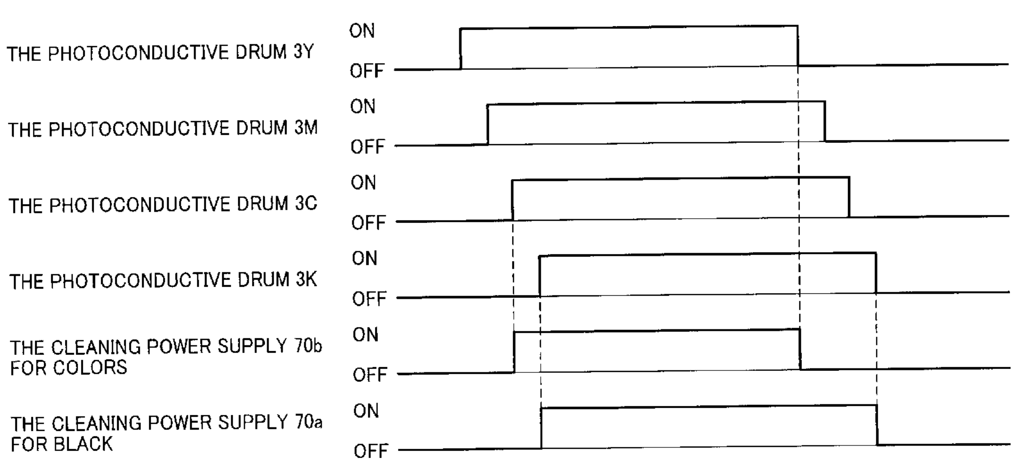
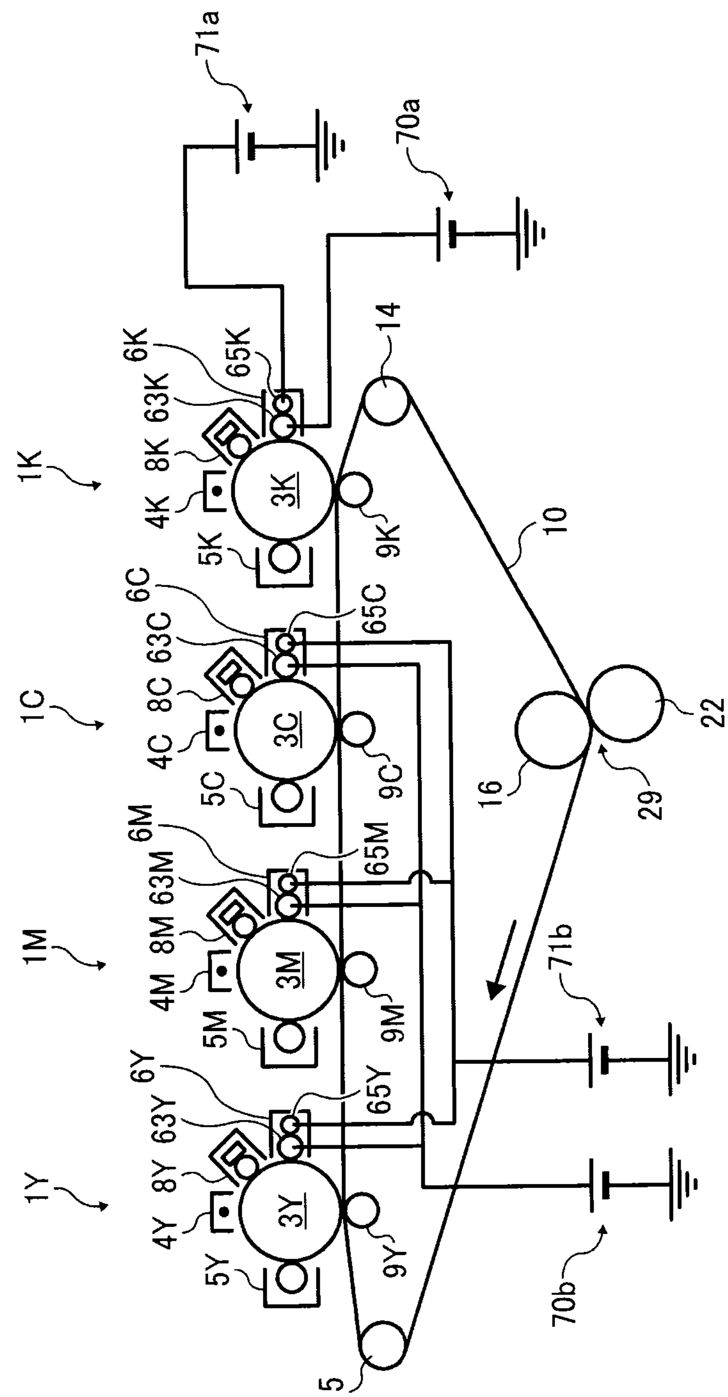


FIG. 1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3M
3C
3K
4Y
4M
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6Y
6M
6C
6K
8Y
8M
8C
8K
9Y
9M
9C
9K
63Y
63M
63C
63K
65Y
65M
65C
65K
10
14
15
16
22
29
70a
70b
71a
71b

FIG. 2

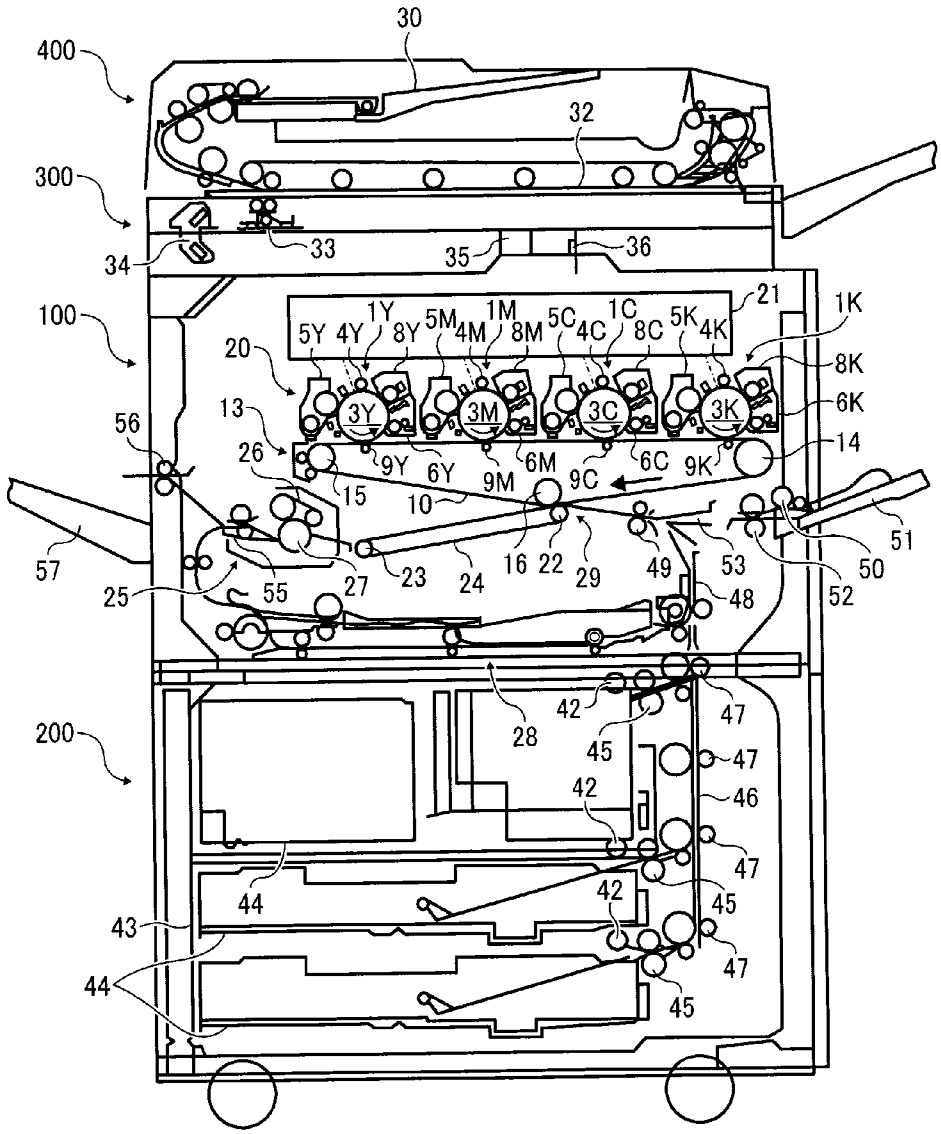

400
30
32
300
33
34
35
36
100
21
1K
5Y
4Y
1Y
8Y
5M
4M
1M
8M
5C
4C
1C
8C
5K
4K
20
8K
3Y
3M
3C
3K
6K
13
56
26
9Y
6Y
6M
6C
9K
14
15
10
9M
9C
57
55
27
23
24
16
22
29
49
53
50
51
52
25
48
28
42
47
45
200
46
44
43

FIG. 3

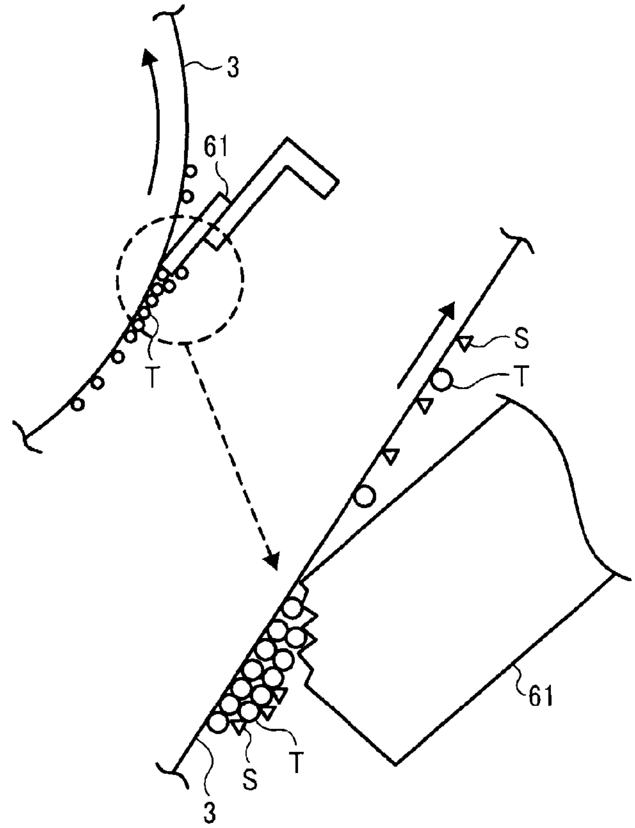


FIG. 4

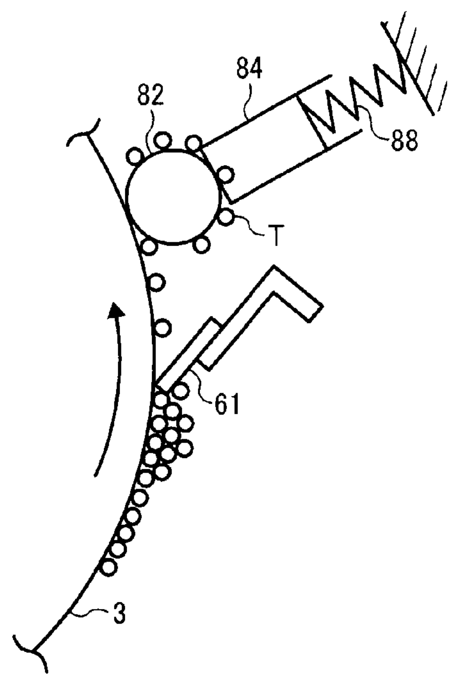


FIG. 5

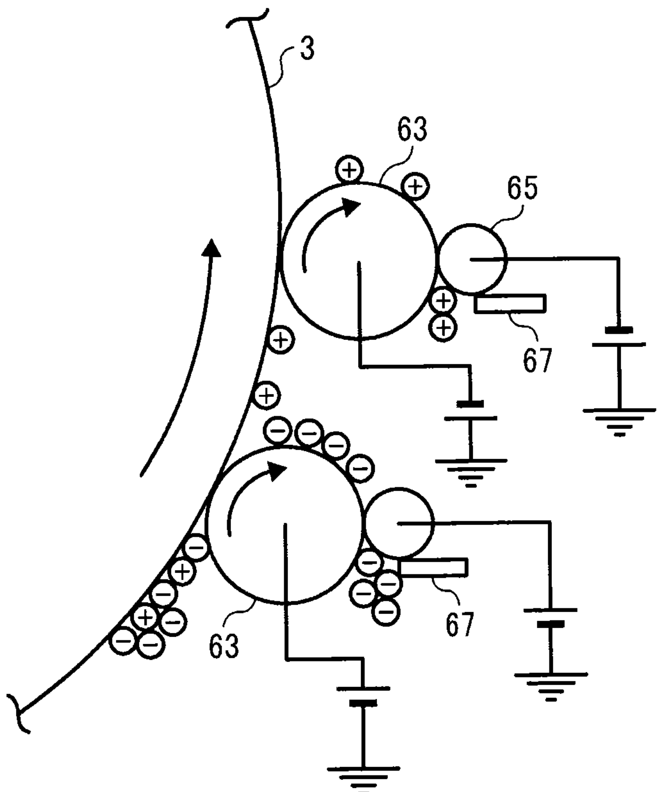


FIG. 6

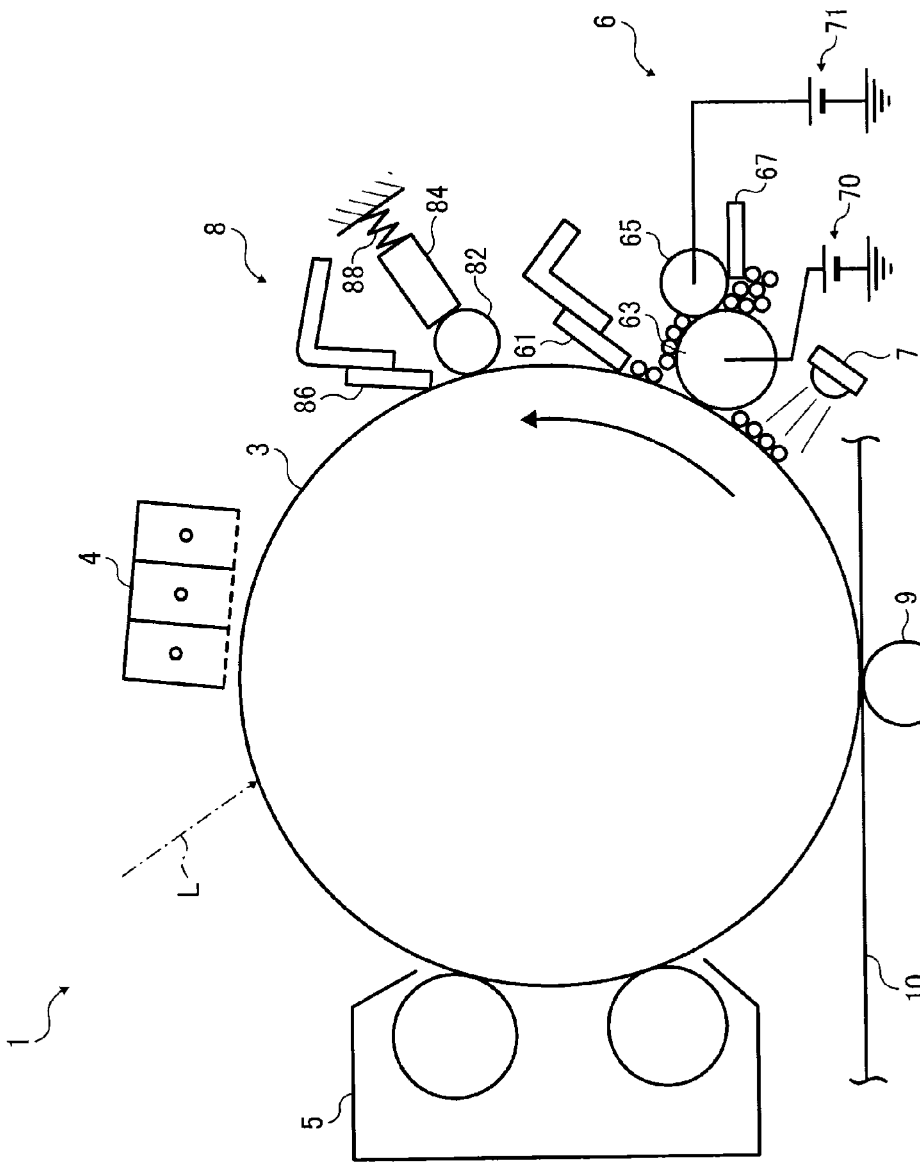


FIG. 7

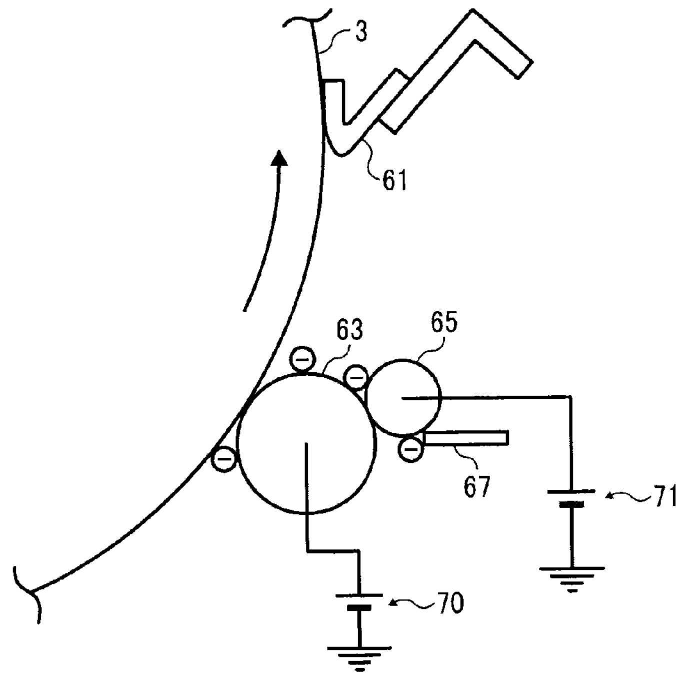


FIG. 8

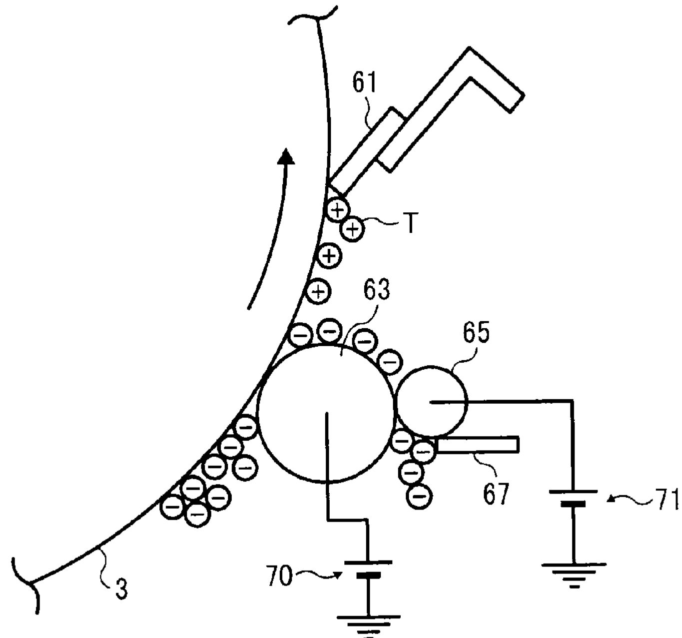


FIG. 9

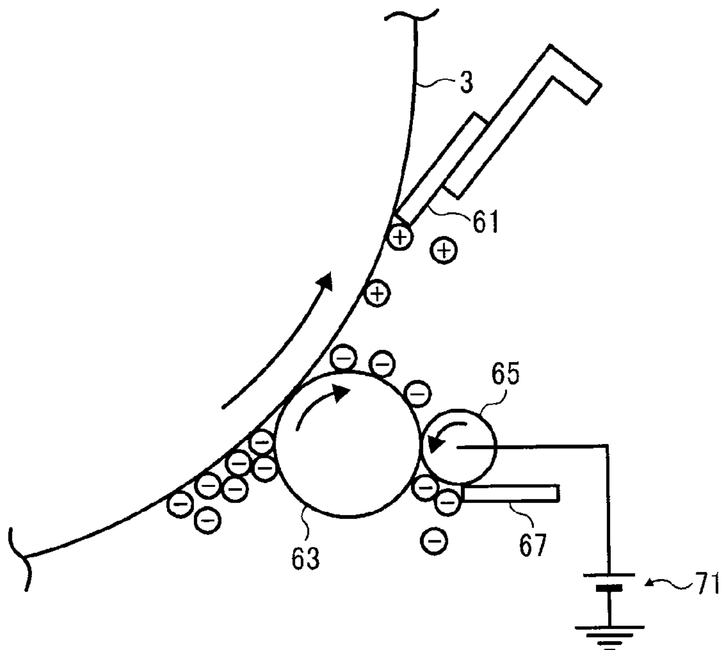


FIG. 10

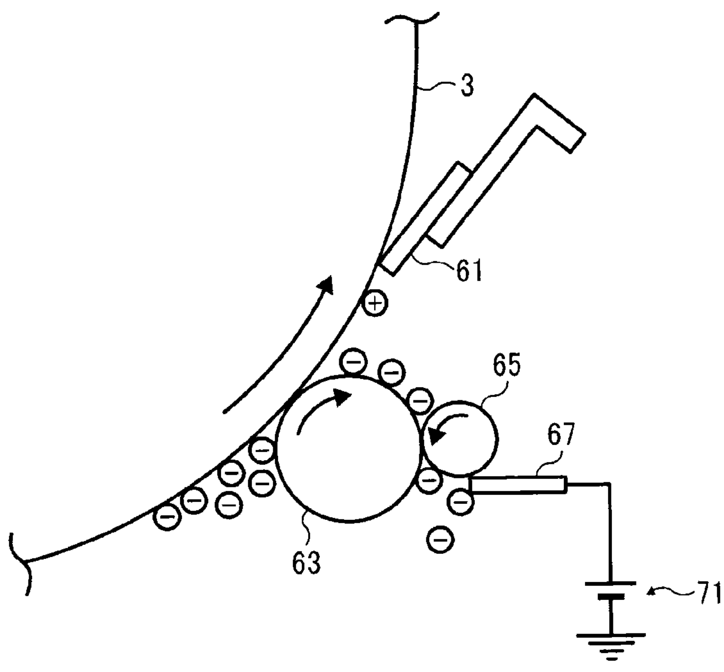


FIG. 11

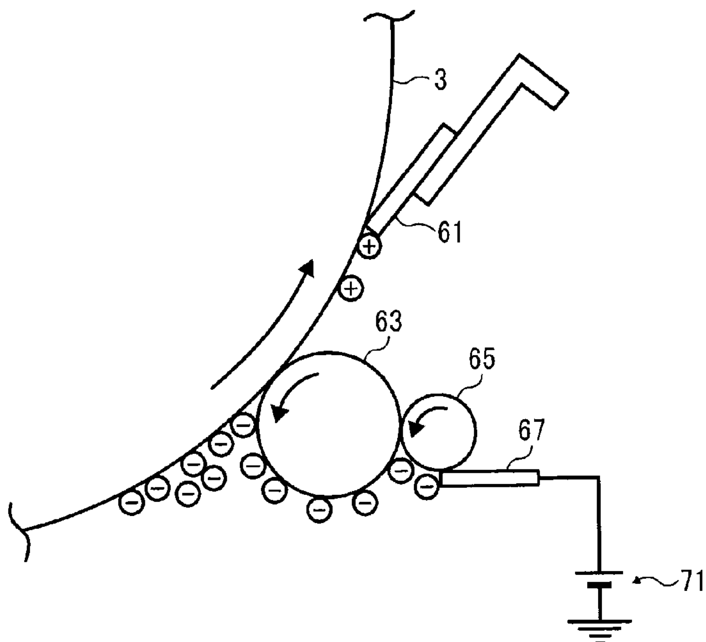
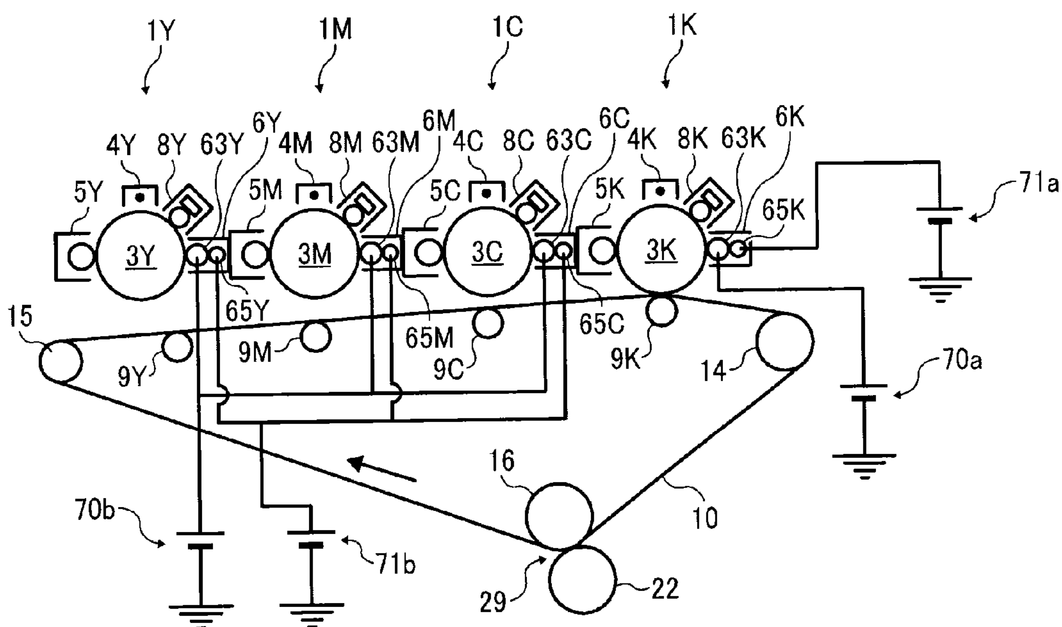

3
61
63
65
67
71

FIG. 12


1Y
1M
1C
1K
4Y 8Y 63Y 6Y
4M 8M 63M 6M
4C 8C 63C 6C
4K 8K 63K 6K
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5C
5K
3Y
3M
3C
3K
65Y
65M
65C
65K
71a
70a
15
9Y
9M
9C
9K
14
16
10
70b
71b
29
22

FIG. 13

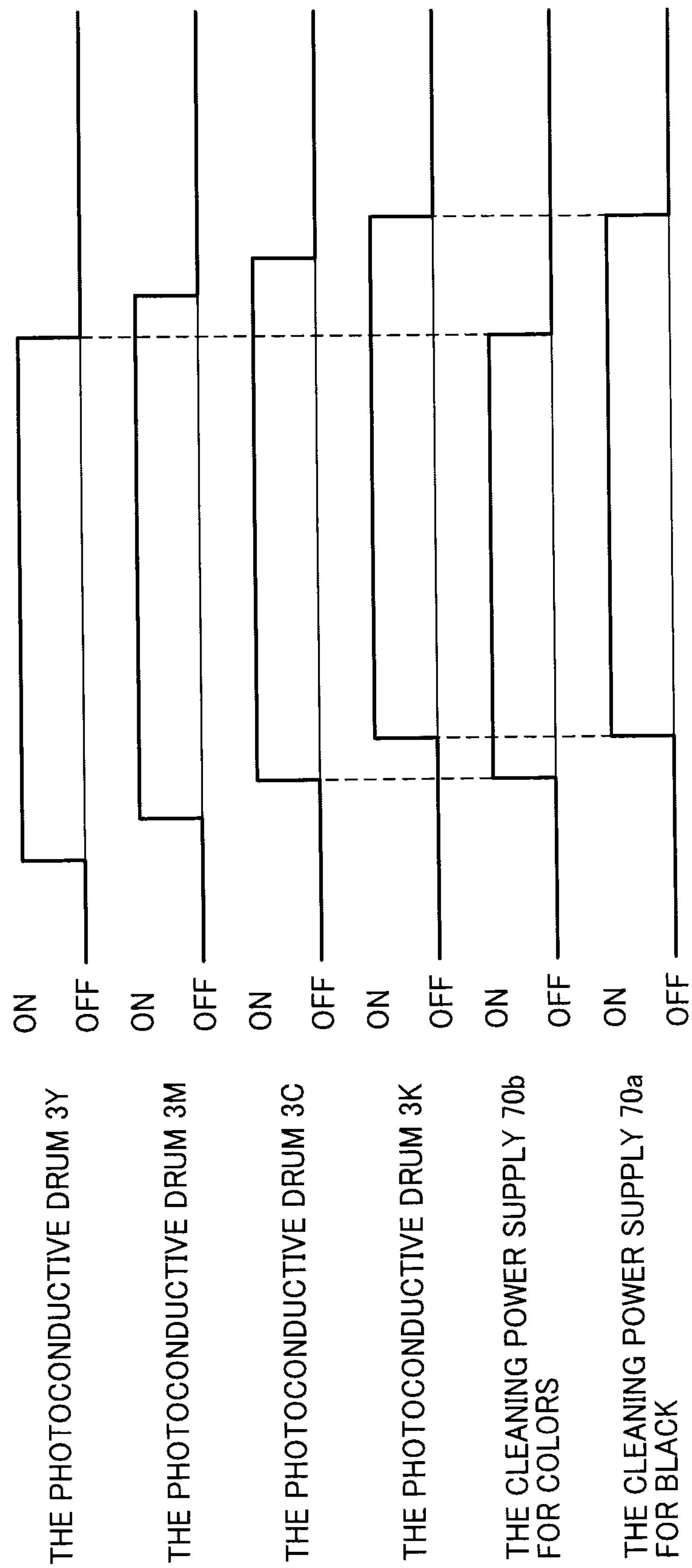
THE PHOTOCONDUCTIVE DRUM 3Y
THE PHOTOCONDUCTIVE DRUM 3M
THE PHOTOCONDUCTIVE DRUM 3C
THE PHOTOCONDUCTIVE DRUM 3K
THE CLEANING POWER SUPPLY 70b FOR COLORS
THE CLEANING POWER SUPPLY 70a FOR BLACK
ON
OFF

FIG. 14

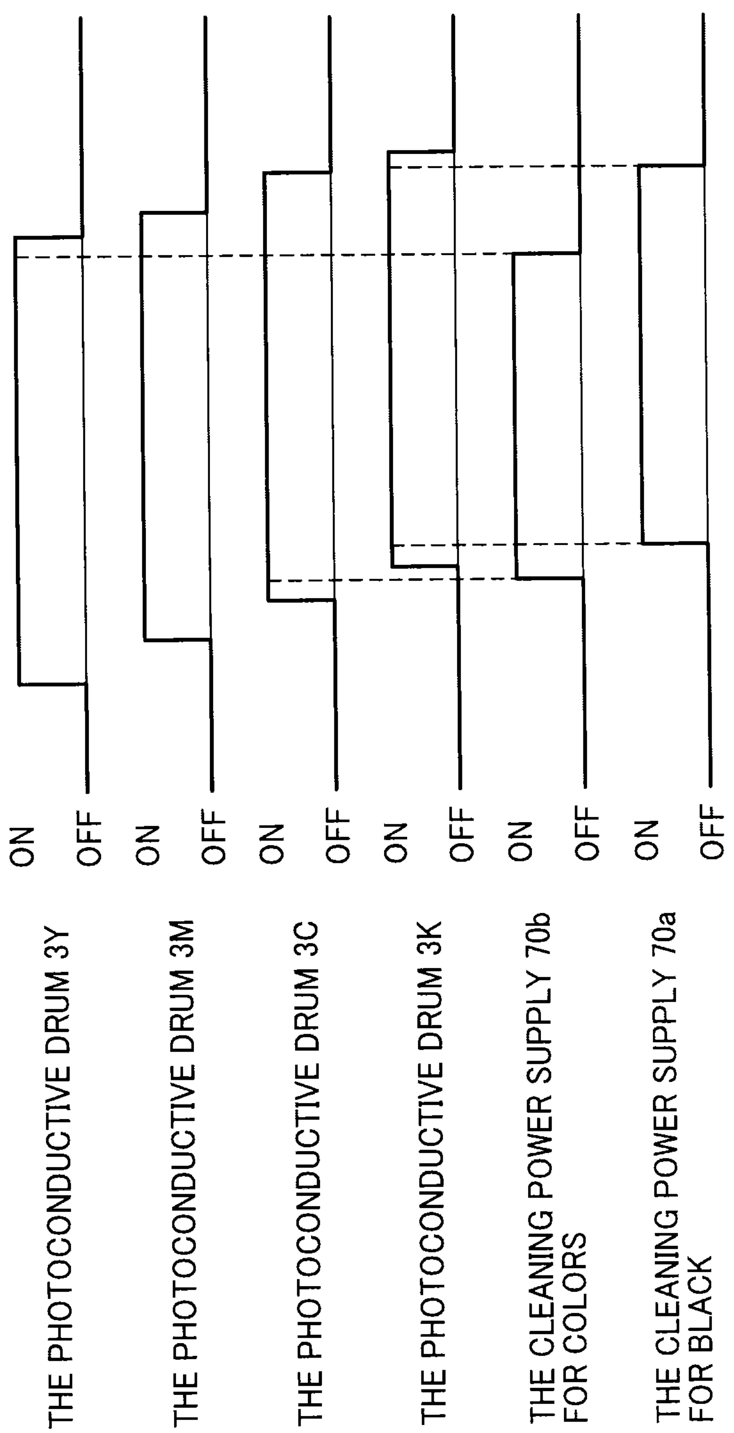
THE PHOTOCONDUCTIVE DRUM 3Y
ON
OFF
THE PHOTOCONDUCTIVE DRUM 3M
ON
OFF
THE PHOTOCONDUCTIVE DRUM 3C
ON
OFF
THE PHOTOCONDUCTIVE DRUM 3K
ON
OFF
THE CLEANING POWER SUPPLY 70b FOR COLORS
ON
OFF
THE CLEANING POWER SUPPLY 70a FOR BLACK
ON
OFF

FIG. 15

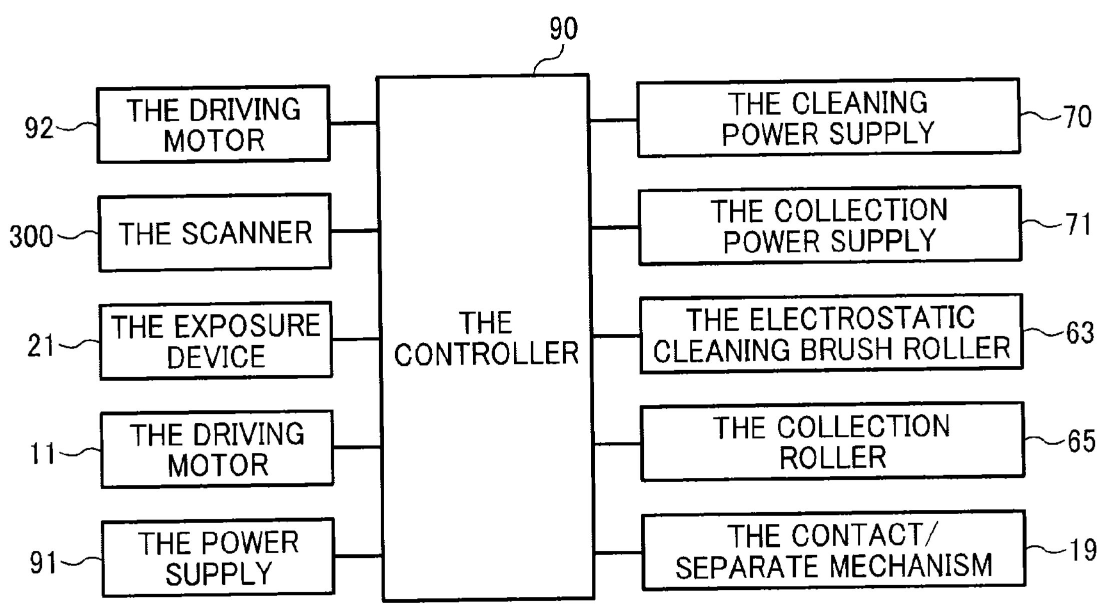
90
92
THE DRIVING MOTOR
300
THE SCANNER
21
THE EXPOSURE DEVICE
11
THE DRIVING MOTOR
91
THE POWER SUPPLY
THE CONTROLLER
THE CLEANING POWER SUPPLY
70
THE COLLECTION POWER SUPPLY
71
THE ELECTROSTATIC CLEANING BRUSH ROLLER
63
THE COLLECTION ROLLER
65
THE CONTACT/ SEPARATE MECHANISM
19

IMAGE FORMING APPARATUS INCLUDING FIRST AND SECOND BIAS VOLTAGE SUPPLY DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority from Japanese Patent Application Nos. 2012-246089, filed on Nov. 8, 2012, and 2013-110185, filed on May 24, 2013, in the Japan Patent Office, the contents of which are incorporated herein by reference in their entirety.

BACKGROUND

1. Field

This disclosure generally relates to an image forming apparatus such as a printer, a facsimile machine, or a copier.

2. Discussion of the Background

A tandem-type image forming apparatus forms a color image to lay a toner image of each color (black, yellow, magenta, and cyan) on the surface of a transfer member. An image-forming unit includes a photoconductive drum, a charge device, a developing device, and a cleaning device. The charge device forms a latent image on a surface of the photoconductive drum charged, which has been uniformly charged. The developing device forms a toner image to develop the latent image. The cleaning device removes untransferred toner on the surface of the photoconductive drum after transferring the toner image to a transfer member.

Japanese Patent No. 4597837 discloses a cleaning device that includes a cleaning brush roller to be rotatable and to contact with a surface of a photoconductive drum and a voltage application member to apply a voltage to a cleaning brush roller for adhering toner electrically. The cleaning brush electrically and mechanically removes the untransferred toner on a surface of the photoconductive drum after transferring the toner image to a transfer member.

A conventional image forming apparatus that includes a power supply unit for each cleaning brush roller of each color (black, yellow, magenta, and cyan) has a high cost and an increased size. Thus, it is necessary to reduce the number of power supply units so that individual power supply units do not apply a bias voltage to each cleaning brush roller.

Further, it is not always necessary to use each colored image-forming unit when using an image forming apparatus included a plurality of image-forming units. Namely, an image forming apparatus can operate in a monochrome mode in which a black toner image is formed using only an image-forming unit for black, and in a color mode in which a color toner image is formed using every image-forming unit.

Therefore, conventionally the power supply unit applies a bias voltage to the cleaning brush rollers of the image-forming units for black as well as yellow, magenta, and cyan, when the image forming apparatus prints a sheet in monochrome mode.

Conventionally, the power supply unit applies power not just to the cleaning brush roller, but also, e.g., to a charge device of the image-forming unit.

SUMMARY

In one embodiment, an image forming apparatus includes a first image forming device to form a toner image, a plurality of second image forming devices to form corresponding toner images, a first bias voltage supply device to apply a first bias voltage to a first component of the first image forming device, and a second bias voltage supply device to apply a second bias voltage to a second component of each of the plurality of the second image forming devices.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic view of each photoconductive drum and an intermediate transfer belt according to a full-color mode;

FIG. **2** is a schematic view of an image forming apparatus according to an illustrative embodiment;

FIG. **3** illustrates a cleaning device using a cleaning blade;

FIG. **4** illustrates a state in which a lubricant applying device applies a lubricant on the photoconductive drum;

FIG. **5** illustrates an electrostatic cleaning device using an electrostatic cleaning brush roller;

FIG. **6** is a schematic view of an image-forming device of the image forming apparatus according to one embodiment;

FIG. **7** illustrates a state in which an entrainment of the cleaning blade occurs;

FIG. **8** is enlarged view of the cleaning device shown in FIG. **6**;

FIG. **9** illustrates a collection roller applying a voltage by a power supply device;

FIG. **10** illustrates a collection blade applying a voltage by a power supply device;

FIG. **11** illustrates an electrostatic cleaning roller rotating in a same direction as the photoconductive drum;

FIG. **12** is a schematic view of each photoconductive drum and an intermediate transfer belt according to a monochrome mode;

FIG. **13** is a timing diagram regarding rotation control of each photoconductive drum and a voltage applying control of the power supply device for black and color;

FIG. **14** is a timing diagram regarding rotation control of each photoconductive drum and a voltage applying control of the cleaning power supply device for black and color; and

FIG. **15** is a block diagram of an image forming apparatus.

DETAILED DESCRIPTION

In describing the implementations illustrated in the drawings, specific terminology is employed for the sake of clarity. However, this disclosure is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve a similar result.

The same members in each configuration are attached with the same reference numbers. In addition, explanations for the same effects in different configuration examples may be omitted.

A structure of a tandem type color image forming apparatus is shown in FIG. **2** as an example of an image forming apparatus according to an exemplary implementation of this disclosure.

FIG. **2** shows a schematic view of an image forming apparatus, according to an embodiment of the present advancements. The image forming apparatus includes a printer part **100** as a main body, a feeding part **200**, a scanner **300** arranged above the printer part **100**, and an auto document feeder (ADF) **400** located on the scanner **300**. Moreover, the image forming apparatus includes a controller **90** (shown in FIG. **15**) that controls the operations of each device of the image forming apparatus.

The printer part **100** includes an intermediate transfer belt **10** serving as an intermediate transfer member located at a center of the printer part **100**. The intermediate transfer belt **10** is looped over a first support roller **14**, a second support roller **15**, and a third support roller **16**, and is driven clockwise. Four photoconductive drums **3**Y, **3**M, **3**C, and **3**K, which correspond to each of yellow, magenta, cyan, and black color toner images, are arranged along a surface of the intermediate transfer belt **10**. Each photoconductive drum carries a corresponding toner image of each color.

Charge devices **4**Y, **4**M, **4**C, and **4**K, which respectively charge equally a surface of the each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, and developing devices **5**Y, **5**M, **5**C, and **5**K, which respectively develop a toner image on the surface of each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, are arranged around each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K. Moreover, cleaning devices **6**Y, **6**M, **6**C, and **6**K, which respectively remove untransferred toner on each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, and lubricant applying devices **8**Y, **8**M, **8**C, and **8**K, which respectively apply a lubricant on the surface of each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, are arranged around each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K.

Image forming devices **1**Y, **1**M, **1**C, and **1**K respectively include photoconductive drums **3**Y, **3**M, **3**C, and **3**K, the developing devices **5**Y, **5**M, **5**C, and **5**K, the charge devices **4**Y, **4**M, **4**C, and **4**K, and the cleaning devices **6**Y, **6**M, **6**C, and **6**K. The four image forming devices **1**Y, **1**M, **1**C, and **1**K are arranged horizontally in a tandem image forming unit **20**.

The image forming devices **1**K, **1**Y, **1**M, and **1**C also may be arranged along a rotating direction of the intermediate transfer belt **10**.

The intermediate transfer belt **10** is sandwiched between the belt cleaning device **13** and the third support roller **15**. The belt cleaning device **13** removes untransferred toner that remains on the surface of the intermediate transfer belt **10**. The printer part **100** includes an exposure device **21** arranged above the tandem image forming unit **20**.

Primary transfer rollers **9**Y, **9**M, **9**C, and **9**K are arranged inside of the intermediate transfer belt **10**, and the primary transfer rollers and the photoconductive drums **3**Y, **3**M, **3**C, and **3**K sandwich the intermediate transfer belt **10**. The primary transfer rollers **9**Y, **9**M, **9**C, and **9**K are primary transfer parts, and press the intermediate transfer belt **10** to the photoconductive drums **3**Y, **3**M, **3**C, and **3**K.

A secondary transfer device **29** includes a secondary transfer roller **22**, a secondary transfer belt extending roller **23**, and a secondary transfer belt **24**. The secondary transfer roller **22** and the secondary transfer belt extending roller **23** extend the secondary transfer belt **24**. A secondary transfer device **29** and the third support roller **16** sandwich the intermediate transfer belt **10** and the secondary transfer belt **24**. The secondary transfer belt **24** and the intermediate transfer belt **10** form a secondary transfer nip.

The fixing device **25** is arranged downstream in a sheet conveyance direction relative to the secondary transfer device **29**, and fixes the toner on the sheet. The fixing device **25** includes a pressure roller **27** and the fixing belt **26**, which is an endless belt. The secondary transfer belt **24** conveys the transferred sheet to the fixing device **25**. The secondary transfer device **29** may include a secondary transfer roller instead of the secondary transfer belt **24**.

A sheet reversing device is arranged under The secondary transfer device **29** and the fixing device **25**, and is arranged parallel with the tandem image forming unit **20**. The sheet-reversing device **28** reverses a sheet for transferring an image to a second surface of the sheet. A switching member **55** switches a sheet-conveyance direction with the sheet-reversing device **28** and a discharge roller **56**. A stack tray **57** stacks the sheet that passes the fixing device **25**.

The scanner **300** includes an image reading sensor **36** to read image information from documents positioned on an exposure glass **32**, and sends the read image information to the controller **90** shown in FIG. **15**

Based on the image information received from the scanner **300**, the controller **90** controls a laser, an LED, or the like positioned in an exposure device **21** that irradiates a writing laser beam "L" (shown in FIG. **6**) onto the photoconductive drums **3**Y, **3**M, **3**C, and **3**K. Through this irradiation, latent electrostatic images are formed on the surfaces of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, and the latent electrostatic images are developed into toner images through an image developing process.

The feeding part **200** includes a sheet bank **43**. The sheet bank **43** includes sheet feeding cassettes **44**, sheet feeding rollers **42** that extract sheets from the sheet feeding cassettes **44**, sheet separating rollers **45** that separate the sheets and feed a sheet sequentially to a sheet feeding path **46**, and sheet conveying rollers **47** that feed the sheet to a sheet feeding path **48**.

In addition to the feeding part **200**, the printer part **100** includes a manual sheet feeder. The manual sheet feeder includes a sheet-feeding tray **51** and a sheet separating roller **52** that separates each sheet.

A resist roller **49** discharges a sheet from any one of the sheet feeding cassettes **44** or the sheet feeding tray **51**, and sends the sheet to the secondary transfer nip.

When making copies of a color document, an operator sets the color document on a document stand **30** of the auto document feeder **400**, or sets the color document on the exposure glass **32**.

Then the operator pushes a START key, the auto document feeder **400** conveys the document onto the exposure glass **32**, and the scanner **300** is activated. Alternatively, when the operator sets a document on the exposure glass **32** and pushes the START key, the scanner **300** is activated immediately to move a primary scanning member **33** and a secondary scanning member **34**.

Light is emitted from a light source at the primary scanning member **33**, and then the light reflects off the surface of the document, and is further reflected towards the secondary scanning member **34**. A mirror of the secondary scanning member **34** reflects the light through an imaging lens **35** onto an image reading sensor **36** that reads the image information.

The charge devices **4**Y, **4**M, **4**C, and **4**K uniformly charge a surface of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K, respectively. The exposure device **21** irradiates the photoconductive drums **3**Y, **3**M, **3**C, and **3**K with image data read by the scanner **300** to form latent electrostatic images on the photosensitive members **3**K, **3**Y, **3**M and **3**C, respectively.

The latent electrostatic images on the photoconductive drums **3**Y, **3**M, **3**C, and **3**K are developed by the developing devices **5**Y, **5**M, **5**C, and **5**K, respectively, to form respective toner images on the surface of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K. A driving motor drives one of the sheet feeding rollers **42** for feeding the sheet corresponding to the image information.

At the same time, a driving motor **11** (shown in FIG. **15**) drives one of the first support roller **14**, the second support roller **15**, and the third support roller **16** to rotate the intermediate transfer belt **10**. The images respectively formed on the surface of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K are sequentially transferred to the intermediate transfer belt **10** in accordance with the rotation of the intermediate transfer belt **10**, completing a full-color image on the surface of the intermediate transfer belt **10**.

One of the sheet-feeding rollers **42** of the sheet feeding part **200** is selectively rotated, and sheets from one of the sheet feeding cassettes **44** are extracted and fed one-by-one, by the sheet separating roller **45**, to the sheet feeding path **46**. The sheet is guided on the sheet feeding path **46** by sheet conveying rollers **47**, and stopped by the resist roller **49**.

Alternatively, a sheet feeding roller **50** rotates to extract a sheet from the manual sheet feeding tray **51**. The sheet separating roller **52** separates sheets one-by-one into a sheet feeding path **53**. The resist roller **49** stops the sheet.

The resist roller **49** rotates to align with the composite color image on the intermediate transfer belt **10** and convey the sheet to the secondary transfer nip. The composite color image is transferred onto the sheet under the influence of an electrical field for image transfer and contact pressure in the secondary transfer nip.

The secondary transfer belt **24** conveys the sheet with the transferred color toner image to the fixing device **25**. The fixing device **25** fixes the color toner image on the sheet with heat and pressure by the pressure roller **27** and the fixing belt. In a simplex print mode, the discharge roller **56** discharges the sheet, and the sheet is stacked on the stack tray **57**.

In a duplex print mode, the switching member **55** guides the sheet to the sheet-reversing device **28**. The sheet-reversing device **28** reverses the sheet and conveys the sheet to the resist roller **49**. The secondary transfer device **29** transfers the color toner image onto a second surface of the sheet. The discharge roller **56** discharges the sheet, and the sheet is stacked on the stack tray **57**.

After the secondary image transfer, the belt cleaning device **13** removes the untransferred toner remaining on a surface of the intermediate transfer belt **10**. The tandem image forming unit **20** prepares the next image formation.

A lifetime of a photoconductive drum and a cleaning device of an image forming apparatus need to be long. In particular, when using an image-forming device according to one embodiment, the lifetime of the photoconductive drum is improved. Further, the running cost of the cleaning device is reduced when a printer, when used for production printing, prints a large number of sheets.

It is necessary to reduce an abrasion speed of an edge of a cleaning blade for improving a lifetime of the cleaning device. The cleaning device using a cleaning blade **61** has a simple construction and almost completely removes toner "T" by contacting a photoconductive drum in a counter direction with respect to a rotation direction of the photoconductive drum **3**, as shown in FIG. **3**.

The lifetime of the cleaning device using the cleaning blade **61** depends on an amount of the abrasion of the edge of the cleaning blade **61**. When the amount of abrasion increases, the toner "T" on the surface of the photoconductive drum **3** passes the cleaning blade **61**, which causes a longitudinal seam image.

When the printer prints a large number of sheets including an image with a high image-area ratio, a large number of the toner particles "T" reach the edge of the cleaning blade **61**. The abrasion of the edge advances when the toner "T" and a lubricant pass the edge of the cleaning blade **61**.

An example of reducing the advance of abrasion of the edge is to ensure that the material of the blade is suitable.

However, it is difficult to improve the lifetime of the blade **61** because properties of a polyurethane rubber can not be dramatically changed. An effective way of dramatically reducing the advance of the abrasion of the edge is to prevent a large amount of toner "T" from reaching the edge.

Next, silica "S", which is an additive agent of the toner, sticks to the surface of the photoconductive drum **3** when the silica passes the edge. When the silica is deposited, the silica bonds to the surface of the photoconductive drum **3**. A region where the silica bonds appears as a white dot in the image because the toner is not able to adhere to the region.

In contrast, the construction shown in FIG. **4** is able to reduce a volume of the toner "T" reaching the edge. For example, the photoconductive drum **3** is protected from silica "S" by a lubricant layer that is formed by a lubricant applying device applying a lubricant of a lubricant body **84** to the photoconductive drum **3**. However, when the printer prints a large number of sheets, including an image with a high image-area ratio, the lubricant applying device needs to apply a larger amount of lubricant. Thus, the lifetime of the lubricant body **84** decreases. Moreover, when the toner "T" that passes the edge adheres to an applying blush **82**, the lifetime of lubricant body **84** also decreases.

Finally, a lifetime of the photoconductive drum **3** shortens from the toner "T" and silica "S" that scrape the surface of the photoconductive drum **3** when passing the edge.

In contrast, the thick surface of the photoconductive drum **3** causes residual electric charge to remain on the photoconductive drum. When a surface potential of the photoconductive drum **3** is not in a predetermined range, an image density changes.

Thus, reducing a thickness between the surface of the photoconductive drum **3** and a charge generation layer prevents a large amount of the toner "T" from reaching the edge.

Alternatively, FIG. **5** shows an electrostatic cleaning device as another cleaning device in which a voltage is applied to an electrostatic cleaning brush roller **63** and removes toner electrically.

A toner-removing ability of the electrostatic cleaning device is higher than that of the cleaning blade. The surface of the photoconductive drum does not adhere silica easily because the electrostatic cleaning device does not stress toner mechanically.

However, the electrostatic cleaning brush roller is unable to remove a little toner whose polarity is different from the polarity of the electrostatic cleaning brush roller. Thus, as shown in FIG. **5**, for removing positive polarity toner and negative polarity toner, a cleaning device needs a plurality of electrostatic cleaning brush rollers and a plurality of toner polarity controllers that adjust toner polarity. However, the cost of such an image forming apparatus is higher.

In one embodiment, an image forming apparatus includes an electrostatic cleaning brush roller and a cleaning blade that are arranged downstream with respect to rotation of a photoconductive drum, and thus eliminate disadvantages of the cleaning blade and the electrostatic cleaning brush roller, as mentioned above.

FIG. **6** shows a schematic view of the image forming device **1** of a present implementation.

As shown in FIG. **6**, the image-forming device **1** includes a process cartridge that accommodates at least the photoconductive drum **3**, a charge device **4**, a developing device **5**, a cleaning device **6**, a charge-removing lamp **7**, and a lubricant applying device **8**. The process cartridge is exchangeable and detachable as a unit from the image forming apparatus. However, each of the photoconductive drum **3**, the charge device **4**, the developing device **5**, the cleaning device **6**, the charge-removing lamp **7**, and the lubricant applying device **8** may be exchangeable.

A cleaning device **6** includes the electrostatic cleaning brush roller **63** and the cleaning blade **61** in order from an upstream side with respect to the rotation of the photoconductive drum **3**.

The electrostatic cleaning brush roller **63** rotates in a same direction of rotation as the photoconductive drum **3**, as indicated by an arrow in FIG. **6**. The electrostatic cleaning brush roller **63** may be a driven roller to rotate against the photoconductive drum **3**.

The cleaning blade **61** is mounted by a holder, and contacts the photoconductive drum **3** in a counter direction with respect to a rotation direction of the photoconductive drum **3**.

A cleaning power supply **70** as a bias voltage applying member applies a bias voltage to the electrostatic cleaning brush roller **63** to remove toner electrically. After transferring a toner image from a photoconductive drum **3** to the intermediate transfer belt **10**, untransferred positive toner and untransferred negative toner on a surface of the photoconductive drum reach a contact portion of the photoconductive drum and the electrostatic cleaning brush roller **63**. The electrostatic cleaning brush roller **63** removes the untransferred toner by electrostatic force and frictional force.

After the charge-removing lamp **7** removes a charge on the surface of the photoconductive drum **3**, the electrostatic cleaning brush roller **63** removes almost all untransferred toner on the surface of the photoconductive drum **3**. After that, the cleaning blade **61** removes untransferred residual toner on the surface of the photoconductive drum.

A collection roller **65**, to which is applied bias voltage by a collection power supply **71**, removes the toner on the electrostatic cleaning brush roller **63** electrically. The collection blade **67**, which contacts a surface of the collection roller **65**, removes the toner on the surface of the collection roller **65**.

The applying blush **82** of a lubricant applying device applies a lubricant on the surface of the photoconductive drum **3** for protecting the surface of the photoconductive drum **3**, after toner is removed by the electrostatic cleaning brush roller **63**.

A lubricating blade **86** contacts the surface of the photoconductive drum **3** in a counter direction with respect to the rotating direction of the photoconductive drum **3**, and smoothes the lubricant on the surface of the photoconductive drum **3**.

The lubricant body **84**, which is mounted on a bracket, is pressed against the applying blush **82** by a pressuring spring **88**. The applying blush **82** wipes the lubricant body **84** and applies the lubricant to the photoconductive drum **3**. Zinc stearate as a lubricant is applied to the whole circumference of the photoconductive drum **3** according to rotation of the photoconductive drum **3**. Thus, by passing granules of Zinc stearat to the cleaning blade **61**, the cleaning blade **61** prevents the photoconductive drum **3** from fitting strongly and prevents an entrainment, as shown in FIG. **7**.

When the printer prints a large number of sheets, including an image with a high image-area ratio according to the construction in FIG. **6**, the developing device **5** develops a toner image on the surface of the photoconductive drum **3** using a large amount of toner.

Thus, there remains a large amount of untransferred toner on the photoconductive drum after transferring the toner to the intermediate transfer belt **10**.

First, the electrostatic cleaning brush roller **63** removes a large amount of untransferred negative toner on the surface of the photoconductive drum **3**.

The electrostatic cleaning brush roller **63** prevents silica from sticking to the surface of the photoconductive drum **3** when the silica passes between the photoconductive drum **3** and the electrostatic cleaning brush roller **63** because the electrostatic cleaning brush roller **63** does not contact the photoconductive drum **3** strongly, and does not stress the untransferred toner mechanically.

A little untransferred positive toner, which is not removed by the electrostatic cleaning brush roller **63**, reaches a contact portion of the photoconductive drum **3** and the cleaning blade **61** according to a rotation of the photoconductive drum **3**.

An edge of the cleaning blade **61** is able to remove the residual toner easily.

Moreover, the edge of the cleaning blade **61** is prevented from an abrasion because little residual toner reaches the contact portion of the photoconductive drum **3** and the cleaning blade **61**. Moreover, the photoconductive drum **3** is prevented from being scraped by toner and adhering silica because the residual toner does not receive stress.

Alternatively, when the printer prints a sheet including an image with a low image-area ratio that is almost all blank, the developing device **5** develops a toner image on the surface of the photoconductive drum **3** using a small amount of toner. Thus, there remains a small amount of untransferred toner on the photoconductive drum **3** after transferring the toner on the intermediate transfer belt **10**. Little untransferred toner reaches a contact portion of the photoconductive drum **3** and the cleaning blade **61** according to a rotation of the photoconductive drum **3** because the electrostatic cleaning brush roller **63** removes almost all of the untransferred toner.

Note that it is unnecessary to increase consumption of the lubricant by arranging the lubricant applying device **8** downstream of the cleaning blade **61** with respect to rotation of the photoconductive drum **3**. Thus, the lubricant applying device **8** improves the lifetime of the image forming device by decreasing consumption of the lubricant.

As mentioned above, each of the electrostatic cleaning brush roller **63**, the cleaning blade **61**, and the lubricant applying device **8** in FIG. **6** improves the lifetime of the image forming device according to the arrangement and construction of those devices.

FIG. **8** is enlarged view of the cleaning device **6** shown in FIG. **6**.

FIG. **8** shows that the cleaning power supply **70** applies a bias voltage to the electrostatic cleaning brush roller **63**, and the collection power supply **71** applies a bias voltage to the collection roller **65**. However, the collection power supply may apply a bias voltage to the collection roller **65**, as shown in FIG. **9**. Moreover, the collection power supply may apply a bias voltage to the collection blade **67**.

A rotation direction of the electrostatic cleaning brush roller **63** is not limited in FIGS. **9** and **10**. The electrostatic cleaning brush roller **63** may rotate in the direction shown in FIG. **11**.

Next, another embodiment of an image forming apparatus is illustrated as follows.

FIG. **1** is a schematic view of a location of each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K and an intermediate transfer belt **10** according to a full-color mode.

When the full-color mode is active, each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K contacts the intermediate transfer belt **10** and forms a transfer nip with each of the primary transfer rollers **9**Y, **9**M, **9**C, and **9**K. The image forming apparatus prints a sheet with a full-color image using all image forming devices **1**Y, **1**M, **1**C, and **1**K.

The exposure device **21** starts to write respective latent electrostatic images on each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K after rotating all photoconductive drums **3**Y, **3**M, **3**C, and **3**K.

Each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K stops rotating after removing untransferred toner on all photoconductive drums **3**Y, **3**M, **3**C, and **3**K using at least the electrostatic cleaning brush roller **63**.

FIG. **12** is a schematic view of a location of each of the photoconductive drums **3**Y, **3**M, **3**C, and **3**K and an intermediate transfer belt **10** according to a monochrome mode.

When the monochrome mode is active, it is not necessary to operate the image forming devices **1**Y, **1**M, and **1**C because the image forming apparatus prints a sheet with a monochrome image using only the image forming device **1**K. Thus, a contact/separate mechanism **19** (shown in FIG. **15**) controls the movement of the intermediate transfer belt **10** in FIG. **12**.

Thus, this construction prevents supplies (such as toner) of the image forming devices **1**Y, **1**M, and **1**C from being overconsumed.

According to the image forming apparatus of one embodiment, the cleaning power supply **70***a* for black applies a bias voltage directly/indirectly to the electrostatic cleaning brush roller **63**K of the cleaning device **6**K.

Alternatively, a single cleaning power supply **70***b* for color applies a bias voltage directly/indirectly to the electrostatic cleaning brush rollers **63**Y, **63**M, and **63**C of the cleaning devices **6**Y, **6**M, and **6**C.

Thus, this construction is able to reduce the number of cleaning power supplies for color compared to that of a cleaning power supply corresponding with each of the electrostatic cleaning brush rollers **63**Y, **63**M, and **63**C, to improve the cost and size of the image forming device.

By separating the cleaning power supply for color and monochrome, power consumption is reduced because the cleaning power supply **70***b* for color does not apply a bias voltage in the monochrome mode.

When the image forming apparatus includes the cleaning power supply **70** and the collection power supply **71**, as shown in FIGS. **1** and **8**, the collection power supply may be constituted as follows. For example, the collection power supply **71***a* applies a bias voltage to the collection roller **65**K. Single collection power supply **71***b* may apply a bias voltage to the collection rollers **65**Y, **65**M, and **65**C. Herewith, the number of the collection power supply for color is reduced compared to that of a collection power supply corresponding with each of the collection rollers **65**Y, **65**M, and **65**C, to improve the cost and size of the image forming device.

When the collection power supply **71** applies a bias voltage to the collection roller **65**, as shown in FIG. **9**, the collection power supply **71***a* for black may apply a bias voltage to the collection roller **65**K, and a single collection power supply **71***b* may apply a bias voltage to the collection rollers **63**Y, **63**M, and **63**C.

Moreover, as shown in FIG. **10**, when the collection power supply **71** applies the collection blade **67**, the collection power supply may be constituted as follows. The collection power supply **71***a* for black may apply a bias voltage to the collection blade **67**K, and the collection power supply **71***b* for color may apply a bias voltage to the collection blades **67**Y, **67**M, and **67**C.

Configuration Example 1

FIG. **13** is a timing diagram regarding a rotation control of each photoconductive drum and a voltage applying control of the power supply device for black and color according to configuration example 1.

When the image forming apparatus starts to print a sheet in full-color mode, a timing when the cleaning power supply **70***b* for color starts to apply a bias voltage is the same timing as the photoconductive drum, which is the last starting time to start rotating among the photoconductive drums **3**Y, **3**M, and **3**C.

The cleaning power supply **70***b* for color starts to apply a bias voltage at a same timing when the photoconductive drum **3**C starts rotating, because the photoconductive drum in FIG. **1** starts rotating in order of the photoconductive drums **3**Y, **3**M, and **3**C.

When finishing an operation of image formation in full-color mode, timing when the cleaning power supply **70***b* for color stops applying a bias voltage is the same timing as the photoconductive drum, which is the first stopping time to stop rotating among the photoconductive drums **3**Y, **3**M, and **3**C. The cleaning power supply **70***b* for color stops applying a bias voltage at a same timing when the photoconductive drum **3**Y stops rotating, because the photoconductive drum in FIG. **1** stops rotating in order of the photoconductive drums **3**Y, **3**M, and **3**C.

Thus, with this timing, the stationary photoconductive drums **3**Y, **3**M, and **3**C are prevented from having the electrostatic cleaning brush rollers **63**Y, **63**M, and **63**C being applied a bias voltage by the cleaning power supply **70***b*, while the rollers from continue to contact the stationary photoconductive drums. As a result, this prevents the photoconductive drums **3**Y, **3**M, and **3**C from density irregularities of image according to a non-uniform charge. Moreover, this prevents the photoconductive drums **3**Y, **3**M, and **3**C from errors resulting from electrostatic bastardization based on long-term operation.

Moreover, when finishing an operation of image formation in full-color mode, timing when the cleaning power supply **70***a* for black starts to apply a bias voltage is the same timing as when the photoconductive drum **3**K starts rotating, regardless of timing when the photoconductive drums **3**Y, **3**M, and **3**C start rotating. Timing when the cleaning power supply **70***a* for black stops applying the bias voltage is the same timing as when the photoconductive drum **3**K stops rotating, regardless of timing when the photoconductive drums **3**Y, **3**M, and **3**C start rotating.

Based on a driving starting signal and a driving stopping signal transmitted to the driving motor **92**, the cleaning power supply **70***a* for black and the cleaning power supply **70***b* for colors control timing of starting and stopping applying a bias voltage.

In case of the collection power supply **71** in FIGS. **9** and **10**, the cleaning power supply **70***a* in FIG. **13** is replaced by the collection power supply **71** for black, and the cleaning power supply **70***b* in FIG. **13** is replaced by the collection power supply **71** for color.

Moreover, when both the cleaning power supply **70** and the collection power supply **71** apply a bias voltage in FIG. **8**, timing when the cleaning power supplies **70***a* and **70***b* in FIG. **13** apply a bias voltage to the electrostatic cleaning brush rollers **63**K, **63**Y, **63**M, and **63**C may be the same timing as when the collection power supply **71** applies a bias voltage to the collection roller **65**. Otherwise, timing when the collection power supply **71** starts to apply a bias voltage to the collection roller **65** or the collection blade **67** is a predetermined time after the cleaning power supplies **70***a* and **70***b* start to apply to a bias voltage in FIG. **13**. The predetermined time is the time it takes for toner to travel from the electrostatic cleaning brush roller **63** to the collection roller **65**.

Configuration Example 2

FIG. **14** is a timing diagram regarding a rotation control of each photoconductive drum **3**Y, **3**M, **3**C, and **3**K and a voltage applying control of the cleaning power supply **70***a* for black and the cleaning power supply **70***b* for color.

When the image forming apparatus starts to print a sheet in full-color mode, a timing when the cleaning power supply **70***b* for color starts to apply a bias voltage is a predetermined time after the photoconductive drum that is the last starting time to start rotating among the photoconductive drums **3**Y, **3**M, and **3**C. The cleaning power supply **70***b* for color starts to apply a bias voltage a predetermined time after the photoconductive drum **3**C starts to rotate, because the photoconductive drum in FIG. **1** starts to rotate in order of the photoconductive drums **3**Y, **3**M, and **3**C.

When finishing an operation of image formation in full-color mode, a timing when the cleaning power supply **70***b* for color stops applying a bias voltage is a predetermined time before the photoconductive drum that is the first stopping time to rotate of the photoconductive drums **3**Y, **3**M, and **3**C. The cleaning power supply **70***b* for color stops applying a bias voltage a predetermined time before the photoconductive drum **3**Y stops rotating, because the photoconductive drum in FIG. **1** stops rotating in order of the photoconductive drums **3**Y, **3**M, and **3**C.

Thus, with this timing, the stationary photoconductive drums **3**Y, **3**M, and **3**C are prevented from having the electrostatic cleaning brush rollers **63**Y, **63**M, and **63**C being applied a bias voltage by the cleaning power supply **70***b*, while the rollers continue to contact the stationary photoconductive drums, as in configuration example 1. As a result, this prevents the photoconductive drums **3**Y, **3**M, and **3**C from density irregularities in an image according to a non-uniform charge. Moreover, this prevents the photoconductive drums **3**Y, **3**M, and **3**C from errors resulting from electrostatic bastardization based on long-term operation, as in configuration example 1.

Moreover, when finishing an operation of image formation in the full-color mode, a timing when the cleaning power supply **70***a* for black starts to apply a bias voltage is a predetermined time after the photoconductive drum **3**K starts to rotate, regardless of timing when the photoconductive drums **3**Y, **3**M, and **3**C start to rotate. A timing when the cleaning power supply **70***a* for black stops applying the bias voltage is a predetermined time before the photoconductive drum **3**K stops rotating, regardless of timing when the photoconductive drums **3**Y, **3**M, and **3**C start to rotate.

Based on a driving starting signal and a driving stopping signal transmitted to the driving motor **92**, the cleaning power supply **70***a* for black and the cleaning power supply **70***b* for color control timing of starting and stopping to apply a bias voltage.

In case of the collection power supply **71** in FIGS. **9** and **10**, the cleaning power supply **70***a* in FIG. **14** is replaced by the collection power supply **71** for black, and the cleaning power supply **70***b* in FIG. **14** is replaced by the collection power supply **71** for color.

The collection power supply **71** may continue to apply a bias voltage to the collection roller **65** after a predetermined time (for example, several minutes) when the cleaning power supply **70** stops applying a bias voltage to the electrostatic cleaning brush roller **63**, in the embodiment of FIG. **8**. Thus, a cleaning performance of the photoconductive drum **3** by the electrostatic cleaning brush roller **63** is maintained because toner on the electrostatic cleaning brush roller **63** is removed by the collection roller **65**.

Moreover, timing when the cleaning power supply **70***a* and **70***b* in FIG. **14** apply a bias voltage to the electrostatic cleaning brush rollers **63**K, **63**Y, **63**M, and **63**C may be the same timing as when the collection power supply **71** applies a bias voltage to the collection roller **65**.

Otherwise, timing when the collection power supply **71** starts to apply a bias voltage to the collection roller **65** or the collection blade **67** may be a predetermined time after the cleaning power supplies **70***a* and **70***b* start to apply a bias voltage. The predetermined time is the time that it takes toner to travel from the electrostatic cleaning brush roller **63** to the collection roller **65**.

The number of the image forming devices **1**Y, **1**M, **1**C, and **1**K are not limited to that shown in FIGS. **1** and **12**. Also, the order of the image forming devices **1**Y, **1**M, **1**C, and **1**K are not limited in that shown in FIGS. **1** and **12**.

Moreover, an object to which the power supply device as the cleaning power supply **70** applies a bias voltage is not limited to the electrostatic cleaning brush roller **63**.

For example, a power supply **91** (shown in FIG. **15**) for black may apply a bias voltage to the charge device **4**K, and a power supply **91** (shown in FIG. **15**) for color may apply a bias voltage to the charge devices **4**Y, **4**M, and **4**C. By separating the power supply for color and monochrome, power consumption is reduced because the power supply for color does not apply a bias voltage in monochrome mode.

A single power supply for color applies a bias voltage to a component, such as the charge devices **4**Y, **4**M, and **4**C.

Thus, the number of the power supplies for color is reduced compared to that of a power supply corresponding with each charge devices **4**Y, **4**M, and **4**C, and the cost and size of the image forming apparatus is improved.

The invention claimed is:

1. An image forming apparatus, comprising:

a first image forming device to form a first toner image, the first image forming device including a first photoconductive member and a first brush;

a plurality of second image forming devices to form corresponding toner images;

a first bias voltage supply device to apply a first bias voltage to a first component of the first image forming device; and

a second bias voltage supply device to apply a second bias voltage to a second component of each of the plurality of second image forming devices, wherein

each second image forming device includes a second photoconductive member that is rotatable and forms the corresponding toner image and a second brush to remove toner on a surface of each second photoconductive member;

each second component is the second brush;

each second image forming device includes a cleaning blade to remove remaining toner after the second brush removes the toner on the surface of the second photoconductive member; and

wherein the second bias voltage supply device stops applying the second bias voltage to each second component at an earliest time among times at which each of the second photoconductive members stops rotating, when finishing each operation of image formation.

2. The image forming apparatus according to claim **1**, wherein

the second bias voltage supply device starts applying the second bias voltage to each second component at a time when a last one of the second photoconductive members starts rotating.

3. The image forming apparatus according to claim **2**, wherein

the first photoconductive member is rotatable and forms the first toner image;

the first bias voltage supply device starts and stops applying the first bias voltage to the first component at a same time that the first photoconductive member starts and stops rotating, respectively.

4. The image forming apparatus according to claim **1**, wherein

each second image forming device includes a second collection member to remove toner on the second brush electrically;

the image forming apparatus further includes a third collection power supply device to apply a voltage to each second collection member for adhering the toner electrically; and

the third collection power supply continues applying the voltage to each second collection member until a predetermined time after the second bias voltage supply device stops applying the second bias voltage to the second brush.

5. The image forming apparatus according to claim **1**, wherein

the first image forming device includes a first charge device to charge a surface of a first photoconductive member;

each second image forming device includes a second charge device to charge a surface of each second photoconductive member;

the image forming apparatus further includes an exposure device to irradiate and write a latent image on a surface of the first and second photoconductive members; and

the first and second photoconductive members stop rotating when the first and second brushes remove toner on the first and second photoconductive members after the exposure device writes a latent image on a surface of the first and second photoconductive members.

6. An image forming apparatus, comprising:

a first image forming device to form a first toner image;

a plurality of second image forming devices to form corresponding toner images;

a first bias voltage supply device to apply a first bias voltage to a first component of the first image forming device; and

a second bias voltage supply device to apply a second bias voltage to a second component of each of the plurality of second image forming devices, wherein

each second image forming device includes a photoconductive member that is rotatable and forms the toner image; and

the second bias voltage supply device stops applying the second bias voltage to each second component before each of the photoconductive members stops rotating, when finishing each operation of image formation.

7. An image forming apparatus, comprising:

a first image forming device, including a first photoconductive member, to form a first toner image;

a plurality of second image forming devices to form corresponding toner images;

a first bias voltage supply device to apply a first bias voltage to a first component of the first image forming device; and

a second bias voltage supply device to apply a second bias voltage to a second component of each of the plurality of second image forming devices, wherein

each second image forming device includes a second photoconductive member that is rotatable and forms the toner image;

each of the second photoconductive members starts rotating at a different time; and

the second bias voltage supply device starts applying the second bias voltage to each second component after each of the second photoconductive members starts rotating, when starting an operation of image formation.

8. The image forming apparatus according to claim **7**, wherein

the first image forming device includes a first photoconductive member that is rotatable and forms the first toner image; and

the first bias voltage supply device starts applying the first bias voltage to the first component after the first photoconductive member starts rotating.

9. The image forming apparatus according to claim **7**, wherein

the first image forming device includes a first photoconductive member that is rotatable and forms the first toner image; and

the first bias voltage supply device stops applying the first bias voltage to the first component before the first photoconductive member stops rotating.

10. The image forming apparatus according to claim **7**, wherein

the second bias voltage supply device stops applying the second bias voltage to each second component before each of the second photoconductive members stops rotating.

11. The image forming apparatus according to claim **7**, wherein

each second image forming device includes a second brush to remove toner on a surface of each second photoconductive member; and

each second component is the second brush.

12. The image forming apparatus according to claim **11**, wherein

each second image forming device includes a second collection member to remove toner on each second brush electrically;

the image forming apparatus further includes a third collection power supply device to apply a voltage to each second collection member for adhering the toner electrically; and

the third collection power supply continues applying the voltage to each second collection member until a predetermined time after the second bias voltage supply device stops applying the second bias voltage to each second brush.

13. The image forming apparatus according to claim **11**, wherein

the first image forming device includes a first charge device to charge a surface of the first photoconductive member;

each second image forming device includes a second charge device to charge a surface of each second photoconductive member;

the image forming apparatus further includes an exposure device to irradiate and write a latent image on a surface of the first and second photoconductive members; and

the first and second photoconductive members stop rotating when the first and second brushes remove toner on the first and second photoconductive members after the exposure device writes a latent image on a surface of the first and second photoconductive members.

14. The image forming apparatus according to claim **1**, wherein

the first image forming device forms a monochrome image when a monochrome mode is active, and the first image forming device and the second image forming devices form a color image when a color mode is active.

15. The image forming apparatus of claim **6**, wherein

the second bias voltage supply device starts applying the second bias voltage to each second component after each of the photoconductive members starts rotating.

16. The image forming apparatus of claim **6**, wherein

each second image forming device includes a second brush to remove toner on a surface of each photoconductive member; and

each second component is the second brush.

17. The image forming apparatus of claim **1**, wherein the first brush removes toner on a surface of the first photoconductive member and the first image forming device further comprises:

a first cleaning blade to remove remaining toner after the first brush removes the toner on the surface of the first photoconductive member; and

a lubricant applying device to apply a lubricant to the surface of the first photoconductive member,

wherein the first cleaning blade is located between the first brush and the lubricant applying device in a rotation direction of the first photoconductive member.

18. The image forming apparatus of claim **1**, wherein the first brush removes toner on a surface of the first photoconductive member and the first image forming device further comprises:

a first cleaning blade to remove remaining toner after the first brush removes the toner on the surface of the first photoconductive member; and

a charge-removing device to remove a charge on the surface of the first photoconductive member,

wherein the first brush is located between the charge-removing device and the first cleaning blade in a rotation direction of the first photoconductive member.

19. The image forming apparatus of claim **6**, wherein the second bias voltage supply device applies a zero voltage to each second component when stopping application of the second bias voltage, before each of the photoconductive members stops rotating, when finishing each operation of image formation.

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